2 National Innovation Systems and Alternative Pathways for Latecomers

2.1 INTRODUCTION

The MIT is a situation where a middle-income economy faces decelerated growth and consequently fails to join the ranks of high-income economies. The MIT has become the subject of an increasing volume of research,[1] and many countries currently have become stagnated at the middle-income stage. A study by the World Bank jointly done with the Development Research Center of the State Council of China (World Bank 2012, p. 12), found that 101 middle-income economies have joined the ranks of the high-income economies since 1960. Among these, the ten economies of Greece, Portugal, Spain, Ireland, Hong Kong, Israel, Japan, Mauritius, Puerto Rico, and Singapore used to be upper-middle-income economies, that is, with income levels of 20–40% of US per capita income. Korea and Taiwan were low- and lower-middle-income economies respectively, and Equatorial Guinea was an oil-exporting country.

This chapter first focuses on these economies to identify alternative pathways to grow beyond the middle-income stage as well as pathways to escape the MIT. The World Bank (2010) has suggested that middle-income economies tend to fall into the MIT because they become caught between low-wage manufacturers and high-wage innovators. In fact, innovation capability has increasingly been recognized as a key prerequisite for middle-income economies to achieve and sustain economic growth.[2] However, the search for

[1] This phenomenon of the MIT was first mentioned in Gill et al. (2007) and has become the subject of an increasing volume of research. For example, see World Bank (2010); World Bank (2012); Eichengreen et al. (2013); and Lee (2013c).

[2] See such works as Lavopa and Szirmai (2018); Eichengreen et al. (2012); Lee (2013c); and Cirera and Maloney (2017).

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growth pathways beyond the middle-income stage does not have to be confined to manufacturing. There are alternatives, such as resource-based development, as witnessed in Chile and Malaysia, which will be explored in this chapter.

This chapter approaches these issues from a Schumpeterian perspective, utilizing the concept of NIS, which is a key theoretical framework of Schumpeterian economics. Lundvall (1992) defined NIS as composed of "elements and relationships which interact in the production, diffusion, and use of new, and economically useful, knowledge." The Schumpeterian thesis suggests that the effectiveness of a country's NIS determines its innovation performance and, by extension, its economic performance.[3] This chapter discusses the alternative pathways for sustaining growth beyond the middle-income stage by classifying the NIS of thirty-two economies around the world into several types. It then confirms the linkages of each NIS type with economic growth.

The chapter will demonstrate that there are two varieties of successful catching-up economies. The first group includes the four economies of Ireland, Spain, Hong Kong, and Singapore from the above-mentioned thirteen economies, as well as the economies of India and Russia. The second group comprises the economies of Korea, Taiwan, and China. In this sense, a central question in this chapter is whether multiple types of NIS exist and whether they represent different pathways of growth beyond the middle-income stage that can enable countries to achieve catch-up with advanced economies in terms of per capita income. If NIS associated with successful catching up can be identified, then it can be compared with the NIS of countries stuck in the MIT, which is characterized by stagnant per capita income (20–40% that of the United States) for long periods of time (World Bank 2012, p. 12). Thus, the NIS of stagnating countries is referred to as the "trapped NIS." The discussion

[3] Such a view is also endorsed by international organizations such as the Organisation for Economic Co-operation and Development (OECD) (1997).

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of various NIS types also connects this study to the broader literature on varieties of capitalism (VoC) by providing some comparisons of NIS types and types of capitalism.[4]

The literature tends to measure NIS by using multiple variables to capture various aspects of an economy, ranging from techno-economic to political-institutional dimensions, IT-related infrastructure, and even openness and financial systems. In comparison, this chapter presents research I conducted with colleagues (Lee, Lee, & Lee, 2021) and uses a narrowly focused measure of NIS that conforms closely with Lundvall's original definition, which highlights NIS's capacity to generate, diffuse, and use knowledge. Therefore, this study uses a single dataset comprising patents filed in the United States. The advantage of using such a dataset is that the data sources are homogeneous, and, therefore, the variables can be easily and consistently collected and measured for different countries over a long period of time.[5] We measured NIS using the following five variables: knowledge localization (diffusion), technological diversification, decentralization of innovators, originality of knowledge, and CTT. In an earlier study (Lee & Lee, 2019), colleagues and I developed a composite NIS index using these five variables and demonstrated that it is a sufficiently comprehensive predictor of economic growth and more robust than, or equally robust as, the index of economic complexity.[6]

The chapter is organized as follows. Section 2.2 discusses the catching up, forging ahead, and falling behind of various economies around the world to derive a hypothesis regarding the grouping of NIS types. Section 2.3 presents the results of cluster analyses of the

[4] The literature on VoC initiated by Soskice and Hall (2001) classifies economies around the world in terms of several key institutions and identifies three representative types of capitalism: liberal market economies, coordinated market economies, and mixed market economies.

[5] Using and relying on patent data can be justified by the fact that the focus of analysis is only on those countries at the middle- or higher-income stage, which tend to file a certain number of patents.

[6] Colleagues and I (Lee & Lee, 2019) showed that adding or omitting one or two components does not affect the explanatory power of NIS in analyzing economic growth. The index of economic complexity is suggested by Hausmann et al. (2014).

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varieties of NIS around the world and economic growth analysis, thus verifying the linkage between NIS types and economic growth. Section 2.4 discusses the dynamic transition from the middle-income to the high-income stage by comparing catch-up NIS with trapped NIS. Section 2.5 discusses the path of catching up with a balanced NIS, with particular attention paid to India. Section 2.6 discusses another alternative path of catch-up that relies not on manufacturing but on resource-based sectors, with Chile and Malaysia presented as examples. Section 2.7 concludes the study by summarizing the main results and discussing the broader implications of the findings.

2.2 CATCHING UP, FORGING AHEAD, AND FALLING BEHIND OF NATIONS

The initial focus of this chapter is the group of economies that have successfully transitioned to become high-income economies, particularly the thirteen economies identified by the World Bank as having sustained growth beyond the middle-income stage (World Bank 2012, p. 12).[7] These economies can be compared with other countries, particularly those stuck in the MIT, as well as high-income economies. I discuss the economic growth of some of these economies in terms of the long-term trends of their per capita GDP relative to that of the United States.

First, Figure 2.1 examines economies that are relatively large and at the upper middle-income stage yet suspected to be in the MIT, namely, Brazil, Argentina, Mexico, Chile, and South Africa. I also add Mauritius to this group for comparison. The per capita GDPs of all six of these countries have remained somewhat stagnant since the 1960s, reporting approximately 20–40% per capita income of that of the United States for more than five decades. Although per capita income in Argentina exceeded 40% of US levels in the 1960s, it subsequently began to decline, eventually dropping below 40%. Given

[7] I excluded those that possess too few patents to be reliable, such as Puerto Rico, Mauritius, and the oil-exporting country of Equatorial Guinea.

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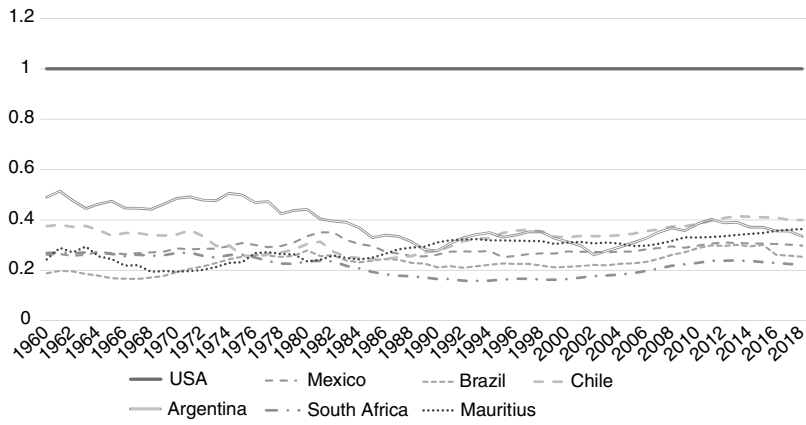

FIGURE 2.1 Per capita income as percentage of that of the United States: Mexico, Brazil, Chile, Argentina, South Africa, and Mauritius
Source: Drawn using data from the Maddison project: www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2020

the homogeneous record of these countries' slow catch-up, one may hypothesize that if their NIS can explain their performance, then they should belong to the same NIS cluster.

Next, I turn to the long-term performance of Asian economies. Figure 2.2 clearly shows that they have displayed a steady catch-up trend, regardless of whether it is slow or fast. This contrasts sharply with the overall trend of stagnation or even decline in Latin America. All the economies in Figure 2.2 started with a per capita income below 20% of that of the United States, which is the threshold for the low middle-income level. Hong Kong is an exception, however, as its income levels were approximately 30% of those of the United States. However, their speed of catch-up displayed some variation. For example, the four East Asian tigers showed faster catch-up, with their per capita GDPs reaching 60% or even 100% of that of the United States. Meanwhile, Thailand and Malaysia remained within the 20–40% range (or the so-called MIT range) until the 2000s. Although China was the only economy classified as a low-income economy in 1960, it has rapidly caught up, reaching 30% of US per capita GDP by the late

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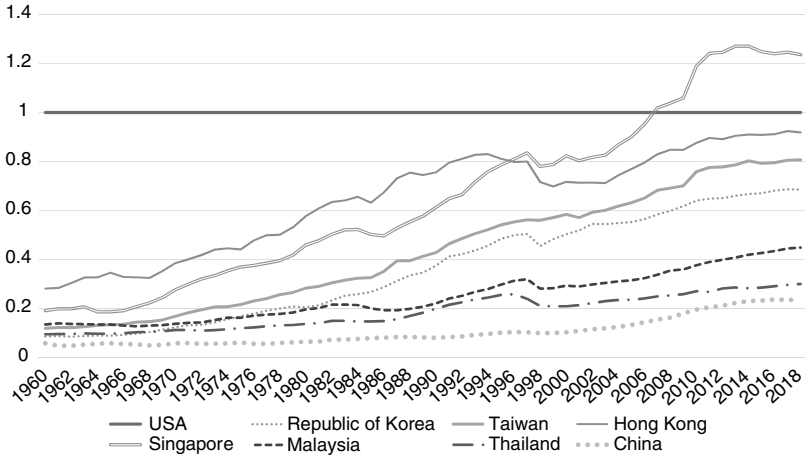

FIGURE 2.2 Per capita income as percentage of that of the United States: Korea, Taiwan, China, Hong Kong, Singapore, Malaysia, and Thailand
Source: Drawn using data from the Maddison project: www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2020

2010s. Given the somewhat slow catch-up in Thailand and Malaysia and considering that some studies suggest that these countries may be stuck in the MIT (Yusuf & Nabeshima, 2009), one can hypothesize that these two economies belong to a different NIS type than their Asian neighbors called Asian tigers. That is, they may belong to the same NIS type as other trapped economies in Latin America. I will provide more evidence for this argument in the next section.

I also compare the long-term performance of peripheral European economies and Israel, which belong to the group of thirteen, with that of the very high-income economies of Hong Kong and Singapore. On closer inspection, some divergence is observed among them, with the economies of Singapore, Ireland, and Hong Kong nearly reaching or exceeding US per capita GDP levels and Israel and Spain reaching 60% of US levels. Finally, Greece and Portugal show very weak performances, recently dropping back down to 40% of US per capita GDP. Given this divergence, one can hypothesize that these economies belong to different NIS group types. This hypothesis, of course,

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is premised on the notion that there is a correspondence between economic performance and NIS, as argued by Schumpeterians.

The above discussion suggests the possibility of multiple NIS groups that each correspond to different catch-up performances. Given the variation in catch-up and stagnation between countries, we can assume that there are one or more catching-up NIS types and at least one trapped NIS type. Indeed, there is one group of economies that has achieved a very high level of per capita GDP, approaching 100% of US levels, and there is another group composed of economies above 60% but below 90% of US levels. There is a third group of economies still below 40% (MIT) or close to 40% (stagnation) of US levels. Of course, there are some outliers, such as Japan, which has a large GDP and a very high number of US patents, and also China, which has a huge GDP and only began catching up in the 1980s, albeit rapidly. Given the intense heterogeneity among these economies in terms of innovation-related aspects, it is interesting to examine how closely the NIS types correspond with growth performance. Additionally, it is notable that Chile and Malaysia have recently shown some signs of growing beyond the MIT to exceed the benchmark of 40% of US GDP levels (Figures 2.1 and 2.2). It would be interesting to investigate the recent catch-up performances of these two economies and their leading sectors. I will turn to these countries in Section 2.5.

The next section discusses NIS measurements and typologies to determine how well they can explain the economic performances of economies according to NIS type.

2.3 VARIETIES OF NIS AND THEIR LINKAGES TO ECONOMIC GROWTH

This section first discusses the varieties of NIS around the world.[8] This book uses a narrowly focused measure of NIS that highlights the NIS mechanisms that generate, diffuse, and use knowledge, that

[8] This section is a shortened version of a longer discussion in Lee, Lee, & Lee (2021).

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is, a single dataset consisting of patents filed in the United States.[9] The advantage of using such a dataset is that the data sources are homogeneous, and the variables can be easily and consistently collected and measured for different countries over a long period of time. NIS is measured using the following five variables: knowledge localization (diffusion), technological diversification, decentralization of innovators, originality, and the CTT.[10] These variables cover various dimensions, such as creation and diffusion (*intra*-national vs. *inter*-national) of knowledge for innovation, decentralization or concentration of innovator distribution, technological diversification (width), wide or narrow sourcing of knowledge (originality), and longevity of knowledge (cycle time) in each economy. In general, the higher the per-capita income of an economy, the higher the values of these five NIS variables of an economy.

The analysis focuses on thirty-two economies around the world, including seventeen economies from Europe and North America and fifteen emerging economies. Among the emerging economies, we first considered the five large economies, or BRICS countries, of Brazil, Russia, India, China, and South Africa. Second, we considered five other economies that are relatively large and at the upper middle-income stage but may be stuck in an MIT: Argentina, Mexico, and Chile in Latin America, as well as Thailand and Malaysia in Southeast Asia. This study includes all the major economies, including the G7, BRICS countries, Southern European countries (Portugal, Italy, Greece, and Spain), the four East Asian tigers (Hong Kong, Singapore, South Korea, and Taiwan), the two second-tier tigers (Thailand and Malaysia), four major Latin American countries, one African country, and one country from the Middle East (Israel). The thirty-two economies adequately represent

[9] The United States Patent and Trademark Office releases patent datasets on a weekly basis. This bulk data has been turned into a user-friendly form by data mining. The data mining followed the method suggested by Potter and Hatton (2013). See Lee, Lee, & Lee (2021) for details.

[10] Some of these variables were first proposed by Jaffe et al. (1993) and Jaffe and Trajtenberg (2002), among others.

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the world in terms of income groups and their combined share of US patents in the world.[11]

Table 2.1 presents the recent values of the five NIS component variables for the thirty-two economies – that is, the average values for the period from 2008 to 2015. Using these five NIS component variables, my colleagues and I conducted a cluster analysis, which has also been applied in the literature on VoC.[12] The objective of this cluster analysis was to classify the thirty-two economies into several clusters using statistically derived measures of similarity and difference based on the five variables. Our analysis identified five clusters, with the United States and Japan remaining as outlier economies given the larger sizes of their economies and their high number of patents.[13] The five clusters and their corresponding countries are listed below, together with group names, which will be explained in the following discussion.

(1) Balanced mature NIS (6): Canada, Germany, France, Italy, Switzerland, and the United Kingdom
(2) Balanced small NIS (4): Sweden, Finland, Israel, and the Netherlands
(3) Balanced mixed NIS (8): Ireland, Spain, Singapore, Hong Kong, Denmark, Norway, Russia, and India
(4) Imbalanced catching-up NIS (3): China, South Korea, and Taiwan
(5) Imbalanced trapped NIS (9): Argentina, Brazil, Chile, Malaysia, Mexico, South Africa, Thailand, Greece, and Portugal

[11] The representativeness of these thirty-two economies is appropriate given that they accounted for more than 97% of US patents on average during the 2015–2017 period (Lee, Lee, & Lee, 2021).

[12] The cluster analysis tests the sample units for the degree of structural commonality among all units. Its outcome is a categorization of the units analyzed that enables the maximization of the coherence of each group (or cluster) and the heterogeneity across different clusters. The cluster analysis initially determines which variables (characteristics) are used, measures the distance between units using the selected variables, and finally classifies the units on the basis of the calculated distance (Rokach & Maimon, 2005; Milligan & Cooper, 1985). See Lee, Lee, & Lee (2021) for details of the cluster analysis conducted.

[13] To demonstrate the robustness of the results of the clustering analysis, clustering was done in two steps or in two sets of countries. The twenty-two representative economies were analyzed in the first round, and all thirty-two economies were analyzed in the second round by adding ten more countries. The results are largely consistent, in that the analysis with thirty-two economies just added more members to the four existing clusters while identifying one more cluster consisting of small high-income economies plus two outliers of the United States and Japan.

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Table 2.1 *Values of the five NIS variables in the sample economies, average 2008–2015*

Countries/ economies	Decentralization (1-HHI)	Knowledge localization	Technological diversification	Originality	Relative cycle time	Average no. of US patents, 2015–2017
United States	0.9946	0.2507	0.9392	0.5119	1.0142	140,523
Japan	0.9808	0.4042	0.8562	0.3792	0.9349	51,347
South Korea	0.8399	0.1316	0.6861	0.3637	0.8427	19,555
Germany	0.9856	0.1444	0.8425	0.4727	1.1027	14,968
Taiwan	0.9769	0.1366	0.6812	0.3456	0.8323	10,523
China	0.9510	0.0451	0.5976	0.3691	0.8514	8,923
France	0.9811	0.1124	0.7215	0.4316	1.0850	6,226
United Kingdom	0.9940	0.0675	0.6924	0.4845	1.1332	3,980
Canada	0.9558	0.0710	0.6955	0.4979	1.0290	3,912
Switzerland	0.9858	0.0626	0.6164	0.4562	1.1545	3,749
Netherlands	0.9096	0.0712	0.5511	0.4704	1.0555	3,645
Sweden	0.8793	0.1019	0.5508	0.4345	1.0306	3,216
Israel	0.9906	0.0657	0.4341	0.5101	1.0267	2,017
Italy	0.9840	0.0897	0.6190	0.4321	1.1639	1,762
Singapore	0.9329	0.0353	0.2977	0.4562	0.8998	1,694
Finland	0.7587	0.0919	0.3904	0.4593	0.9754	1,632
Denmark	0.9774	0.0799	0.3542	0.4691	1.1667	1,002
India	0.9708	0.0271	0.2614	0.4030	1.0044	808
Ireland	0.9475	0.0244	0.2235	0.5010	0.9992	734

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Hong Kong	0.9715	0.0469	0.2974	0.4134	1.0070	530
Spain	0.9875	0.0395	0.3219	0.4287	1.1015	492
Norway	0.9860	0.0698	0.2660	0.5061	1.1878	478
Brazil	0.9714	0.0234	0.1658	0.4231	1.2178	165
Russia	0.9394	0.0431	0.1418	0.4644	0.9717	154
South Africa	0.9678	0.0620	0.1296	0.4612	1.2503	86
Mexico	0.9543	0.0193	0.1036	0.5113	1.2109	84
Malaysia	0.9142	0.0337	0.1045	0.4228	1.0527	80
Portugal	0.9431	0.0236	0.0414	0.4234	1.1558	48
Chile	0.9429	0.0169	0.0391	0.4368	1.2233	34
Greece	0.9248	0.0123	0.0417	0.3782	1.1764	32
Thailand	0.8751	0.0091	0.0380	0.4501	1.0924	22
Argentina	0.9400	0.0376	0.0417	0.3959	1.1776	17
Mean	0.9473	0.0766	0.3982	0.4426	1.0665	
Standard deviation	0.0509	0.0778	0.2798	0.0460	0.1160	

Source: Adapted from Lee, Lee, and Lee (2021), Table 1.

These five NIS clusters appear reasonable, particularly considering the VoC literature, which also discusses three or four types of capitalism, including East Asian capitalism. Roughly, the first cluster seems to coincide with the mixed market economies of continental Europe and the liberal market economies of the United Kingdom and Canada. The second group corresponds to the coordinated market economies of Northern Europe, and the fourth group corresponds to East Asian economies.[14] The original literature on VoC tends to focus on advanced economies; the current study, however, grants increased representation to the emerging economies of groups 3, 4, and 5. We decided to focus on these three clusters (3, 4, and 5), as they include many emerging countries. Group 1 serves as a benchmark for the three emerging country groups. Thus, although all five clusters are represented in Table 2.2, our analysis and discussion avoid Group 2, which includes small high-income countries.

The main characteristics of these NIS clusters are evidenced by the values of the NIS variables for each cluster, as shown in Table 2.2. The four groups can be divided into two general groups: balanced and imbalanced NIS. The two balanced NIS groups (1 and 3) tend to have high values for all five of the NIS component variables. In contrast, the imbalanced groups show a very imbalanced, diverging distribution for the five NIS component variable values. Interestingly, the balanced groups include mostly high-income economies, along with Russia and India, whereas the imbalanced group is mostly emerging economies and the peripheral European economies of Greece and Portugal. This implies that having similarly high NIS values may be one attribute of a high-income economy or an attribute of large countries, as demonstrated by India. Let us turn to each of these clusters for further detailed analysis.

First, the cluster of the four major European economies of Germany, France, the United Kingdom, and Italy also includes Canada and Switzerland. This group is referred to as the "balanced

[14] See Storz et al. (2013) and the other articles in the special issue of the *Socio-Economic Review* on Asian capitalisms.

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Table 2.2 *Comparison of NIS by selected groups*

Group	Nations	Decentralization (1-HHI)	Localization	Diversification	Originality	Relative cycle time	NIS_5	Average no. of patents per year	Coefficient of variation (five NIS indicators)	Growth of per capita income (%)
Balanced mature NIS	Canada, France, Germany, Italy, Switzerland, UK	0.9811	0.0913	0.6979	0.4625	1.1114	3.394	4,725	0.285	0.04
Balanced mixed NIS	Denmark, Hong Kong, India, Ireland, Norway, Russia, Singapore, Spain	0.9641	0.0458	0.2705	0.4552	1.0423	2.423	493	0.530	1.51
Balanced catching-up group	Hong Kong, Ireland, Singapore, Spain	0.9599	0.0365	0.2851	0.4498	1.0019	2.291	533	0.580	1.52
Balanced small NIS	Finland, Sweden, Israel, Netherlands	0.8846	0.0827	0.4816	0.4686	1.0221	2.651	1,804	0.221	0.21

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Table 2.2 *(cont.)*

Group	Nations	Decentralization (1-HHI)	Localization	Diversification	Originality	Relative cycle time	NIS_5	Average no. of patents per year	Coefficient of variation (five NIS indicators)	Growth of per capita income (%)
Imbalanced catching-up NIS	China, South Korea, Taiwan	0.9226	0.1044	0.6550	0.3595	0.8421	2.489	8,426	0.628	4.39
Imbalanced trapped NIS	Argentina, Brazil, Chile, Greece, Malaysia, Mexico, Portugal, South Africa, Thailand	0.9371	0.0264	0.0784	0.4336	1.1730	2.109	58	0.714	0.74
Imbalanced trapped group	Argentina, Brazil, Chile, Malaysia, Mexico, South Africa, Thailand	0.9380	0.0289	0.0889	0.4430	1.1750	2.173	67	0.685	1.51

Note and sources: Adaptation of Table 2 in Lee, Lee, & Lee (2021). NIS5 index values are a summation of the five NIS components values after normalization (Lee & Lee, 2019).
All values are average values for the 2008–2015 period. Coefficients of variations are calculated using the normalized values of the five NIS component variables.

mature NIS" cluster because all these economies are high-income economies and because, most importantly, the values of the five variables are all equally high and thus balanced. We can measure and compare varieties of NIS using the five variables and make a composite index by taking a summation of the five component variables after performing normalization and assigning the variables a value from 0 to 5. The actual values in Table 2.2 clearly indicate that the first group, which is the balanced mature NIS cluster, boasts the highest index value, which is indicated as variable NIS5 (3.39) in Table 2.2. The low variation is indicated by the very low values for the coefficient of variation (0.29 in Table 2.2) of the normalized values for the five NIS variables. The equally high values of the NIS variables as well as the high value of the composite index (NIS5) in this group are consistent with the results of the growth regression in my previous work with colleagues (Lee & Lee, 2019), confirming a robust relationship between composite NIS indices and economic growth.

Group 3 is somewhat mixed, in that it includes India as well as the high-income economies of Singapore, Hong Kong, Denmark, and Norway. This group is referred to as the "balanced mixed NIS" cluster. India might look strange in this group given its low-income level; however, it has a similar number of patents to other countries in this group (see Table 2.1). India is included in this balanced group due to its strength in both short-cycle and long-cycle technology-based sectors (IT and pharmaceuticals respectively). By comparison, the balanced mixed NIS has a smaller NIS5 value of 2.42, and thus, if we were to draw a radial graph, it would be nested inside the boundary of the large balanced NIS. In this mixed NIS group, the values of the five NIS variables tend to be lower than the corresponding values in the first group (balanced mature).

Among the eight economies in the balanced mixed NIS cluster, we focus on the four economies of Hong Kong, Ireland, Singapore, and Spain. These four countries belong to the list of thirteen economies provided by the World Bank (2012), meaning that

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they have successfully transitioned from middle- to high-income status. These four economies show an NIS5 value of 2.29 in Table 2.2, and although they are still balanced, they are nested inside the boundary of the balanced mixed NIS economies. We refer to this group as the "balanced catching-up" group, given the countries' successful catch-up performance (see Figure 2.1 and the discussion in Section 2.2).

The remaining two clusters (Groups 4 and 5) tend to consist of emerging economies, and both can be said to have imbalanced NIS based on the considerable differences among the values of the five NIS variables, with their coefficients of variation above 0.6 and, in some cases, even 0.7. Group 4, which is the "imbalanced catching-up NIS" cluster. This cluster is comprised of the three East Asian economies of China, South Korea, and Taiwan, which have demonstrated rapid growth and catch-up. Group 5 includes other emerging economies, namely Argentina, Chile, Thailand, Malaysia, Brazil, and Mexico, and this group is called the "imbalanced trapped NIS" cluster.

An interesting contrast exists between the imbalanced catching-up cluster and the imbalanced trapped cluster: The former corresponds to high localization and diversification yet very short CTT and low originality, and the latter corresponds to very long CTT and high originality yet very low localization and diversification. That is, these two clusters are exact opposites, except that both share a similar level of decentralization and an equally higher concentration compared with the balanced NIS clusters. However, the gap in the composite NIS5 values of these two imbalanced groups is quite substantial, with values of 2.49 for catching-up and 2.11 for trapped, which is consistent with their divergent growth records (Figures 2.1 and 2.2).

In other words, one of the reasons why we use the terms "catching-up NIS" and "trapped NIS" is because they reflect the different performances of each of the two clusters in terms of economic growth, especially their performance in catching up (or not) to the per capita income levels of those in the balanced mature clusters,

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which are composed of the traditional high-income economies. The simple growth rates in Table 2.2 show that the imbalanced catching-up NIS cluster boasts the highest rate of per capita income (4.39% per annum), followed by the balanced catching-up group (1.52%) and finally the imbalanced trapped group (0.74%).

We have also conducted a similar cluster analysis that used the multi-period NIS values of thirty-two economies to analyze a longer period of time: the thirty-two years from 1984 to 2015.[15] A key finding from this dynamic analysis is that there used to be a big mixed group in the mid-1980s, which comprised most of the thirteen economies that escaped the MIT, as well as other economies stuck in the MIT. Then, gradually over time, two catching-up clusters, balanced and imbalanced, emerged. For instance, in the mid-1980s the economies of South Korea, Taiwan, and China all belonged to the same group as other emerging economies. Then, during the second period (1992–1999), South Korea exited this group to create a new group, which was then joined by Taiwan during the third period and finally by mainland China in the mid-2000s, with the three of them eventually forming this imbalanced catching-up NIS cluster. Another pathway is that taken by countries in the balanced mixed NIS group, which include Hong Kong, Singapore, Spain, and Ireland. This group was created by Singapore during the second period, which was soon joined by Ireland and then Hong Kong and Spain.

The above discussion suggests two alternative pathways to a high-income economy status, ultimately avoiding the MIT. Given that they have displayed rapid growth, it is important to identify the key variables that drove them to achieve this feat. On the one hand, simply looking at the number of patents cannot fully explain the emergence of these two groups, because the average number of patents of the balanced catching-up group (533 a year) is considerably lower than that of the balanced mature NIS group (4,725 a year;

[15] We used eight-year average values by dividing the thirty-two years into four subperiods for every eight years. The analysis was conducted using several methods to test the robustness of the results. For details, see Lee, Lee, & Lee (2021).

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Table 2.2). On the other hand, the other catching-up group, consisting of China, Korea, and Taiwan, has maintained a quite imbalanced NIS and thus is distinct from the advanced economies. Nevertheless, these countries have been catching up rapidly in terms of number of patents (reaching 8,426 a year).

Finally, to confirm the divergent growth performances of various NIS groups, my colleagues and I (Lee et al., 2021) conducted cross-country panel regressions. We created a dummy variable for each NIS cluster and conducted growth regressions to match these dummies to their growth performance for the eight four-year subperiods (1984–2015). Economic growth rates were shown to be higher for the two catching-up NIS groups. Compared to the benchmark group, which is comprised of the major advanced economies with balanced NIS, the imbalanced catching-up NIS displayed the highest rate of growth, followed by the balanced catching-up group. In contrast, the trapped NIS economies tended to show no catch-up, with growth rates lower than that of the benchmark group.

2.4 CONTRASTING PATHWAYS OF THE TWO IMBALANCED NIS: CATCHING-UP VERSUS TRAPPED

The preceding section demonstrated the superior economic growth performance of the two catching-up NIS. Thus, it is now necessary to ask how these catching-up NIS emerged, overcame the trapped NIS condition, and progressed to catching-up NIS status. A clue to answering this question can be found in an examination of the dynamic evolution of economies belonging to each NIS cluster. The variable of the CTT trend seems to be the key driving force in the transition to the catching-up NIS.

Figure 2.3A shows the trend of CTT over time for the four NIS groups. We can see that in the 1980s, the imbalanced (short cycle) catching-up group (China, South Korea, and Taiwan) maintained a level of average CTT similar to those of other middle- or high-income economies; however, they have substantially reduced their average CTT since the mid-1980s by specializing in short-CTT

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sectors, such as IT. This is consistent with the fact that their catch-up started in the mid-1980s, although this new NIS cluster did not emerge until the 1990s. In comparison, the average CTT of advanced economies remained high, which is consistent with their strength in long-CTT sectors, such as pharmaceuticals, machine tools, and high-tech materials.

South Korea and Taiwan underwent similar processes of take-off, which relied on the so-called original equipment manufacturing (OEM) mode in labor-intensive sectors (Hobday, 1995) in the 1960s and 1970s.[16] In China, this process began in the 1980s and 1990s. However, countries that industrialize based on the OEM mode cannot maintain competitiveness in the long term because the country's wage rates will continue to rise relative to other lower-tier emerging economies, which is exactly the symptom of the MIT. Korea, Taiwan, and China all belonged to the same trapped group at one time. However, in the 1980s, Korea and Taiwan began to move into high value-added, short-CTT sectors, such as IT, with the help of various industrial policies, including public–private R&D consortiums involving public research institutes, such as the Industrial Technology Research Institute in Taiwan and the Electronics and Telecommunications Research Institute in Korea.[17] China made a similar transition into high value-added, short-CTT sectors in the 1990s.

The CTT of a patent is measured by the average backward citation lag of the patent. This involves such factors as the age of other patents cited by the patent and whether the innovation represented by a patent relies on old or recent knowledge. Specialization by a firm or nation in short CTT-based technologies means that innovation can be conducted with less need to cite or rely on old or existing patents owned by incumbents. Thus, this specialization is reasonable and can be a niche strategy for latecomers because short-CTT areas

[16] Hobday (1995a, 1995b) defined original equipment manufacturing as a form of subcontracting in which a complete and finished product is produced in accordance with the specifications of the buyer.

[17] For details, please refer to Hou and Gee (1993); Kim (1993); and Lee (2013c, chapters 7–8).

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have lower entry barriers, given that technologies tend to be quickly outdated or disrupted in short-CTT-based sectors (Lee, 2013c). This specialization into short CTT also helps latecomers to quickly increase their knowledge localization, especially because short CTT relies less on the knowledge base of advanced economies that have a strong reliance on long CTT. Furthermore, if a latecomer repeatedly enters newly emerging technology sectors, it will also be technologically diversified. Specialization into short CTT also implies improved growth prospects due to the frequent arrival of innovations and increased opportunities.

Figures 2.3B and 2.3C show the increasing trend (or catching up to the level of mature advanced economies) of technological diversification and knowledge localization in the imbalanced catching-up group, which includes China, South Korea, and Taiwan. This catching up contrasts with the stagnation of these variables in the imbalanced trapped group. This contrast is the key difference between the two NIS groups. In other words, there seems to be some correspondence between short (or long) CTT specialization and a high (or low) degree of technological diversification and knowledge localization, at least in the context of latecomer economies. This can be further discussed with reference to the specialization pattern of the trapped economies. In contrast to catching-up economies specializing in short-CTT sectors, the trapped economies have pursued specialization into extremely long-CTT sectors that are even longer than those found in advanced economies. The reasons for the stagnation of localization and diversification, as well as the associated slow economic growth of trapped NIS countries, can be explained using the same logic. In other words, because these countries specialize in extremely long CTT, they must continually cite and rely on patents owned by incumbent high-income economies. This reliance corresponds with a low possibility of increasing knowledge localization, as shown by the stagnant trend of this variable in Figure 2.3C. Moreover, by entering long-CTT sectors, these countries are necessarily engaging in activities similar to those of

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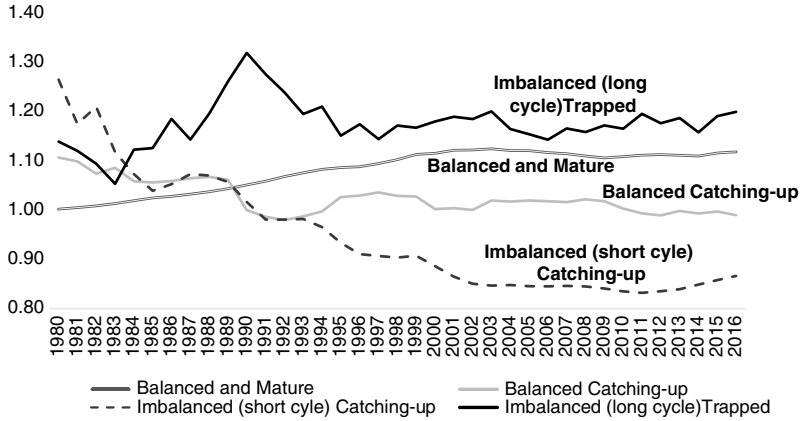

FIGURE 2.3A Dynamic changes of NIS variables: relative cycle time of technologies
Notes: (1) Balanced mature: Canada, Germany, France, Italy, Switzerland, and the United Kingdom
(2) Balanced catching-up: Hong Kong, Ireland, Singapore, and Spain
(3) Imbalanced (short cycle) catching-up: China, South Korea, and Taiwan
(4) Imbalanced (long cycle) trapped: Argentina, Brazil, Chile, Malaysia, Mexico, South Africa, and Thailand
Source: Author's adaptation of a table from Lee, Lee & Lee (2021).

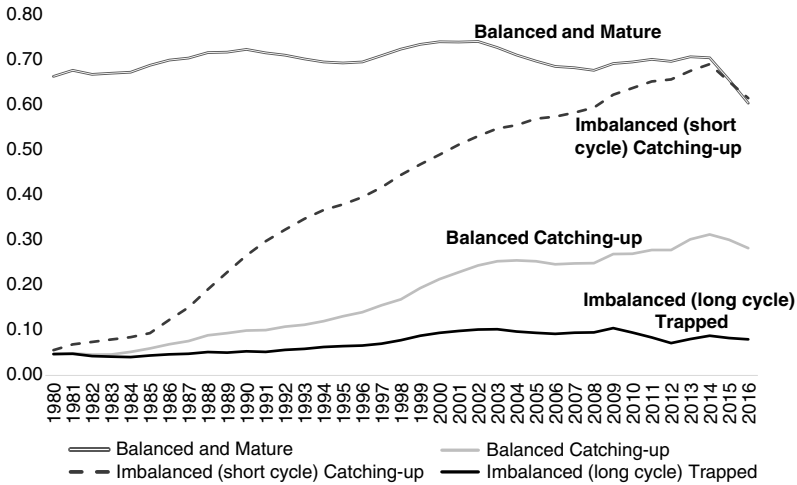

FIGURE 2.3B Dynamic changes of NIS variables: technological diversification
Notes: The same as for Figure 2.3A

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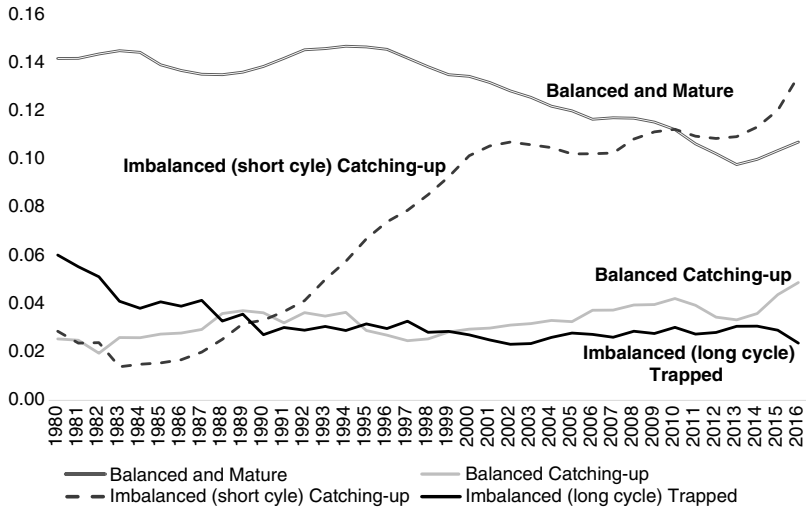

FIGURE 2.3C Dynamic changes of NIS variables: knowledge localization
Notes: The same as for Figure 2.3A

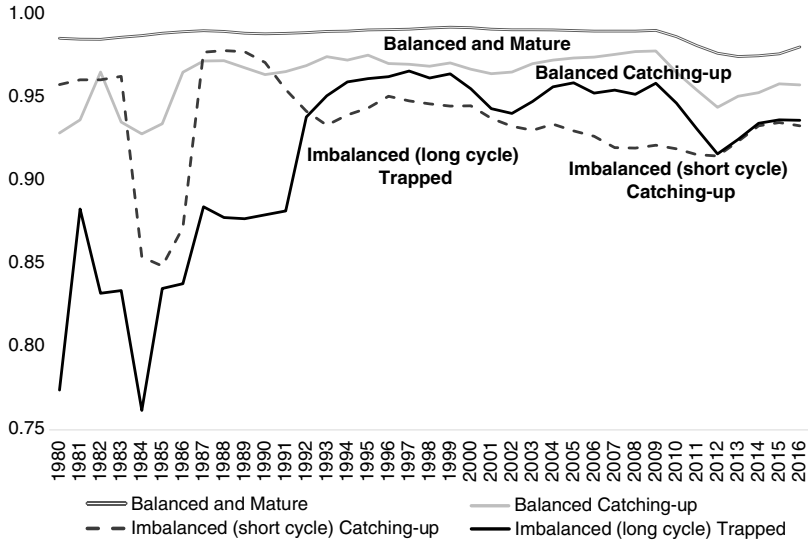

FIGURE 2.3D Dynamic changes of NIS variables: decentralization of innovations
Notes: The same as for Figure 2.3A

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incumbent economies. Therefore, they are unable to identify any niche and face high entry barriers to new, successive innovation and commercialization. This pattern is consistent with the observation that there exists a decoupling of academic research and industrial commercialization in Latin America, which has been highlighted as a weakness of NIS in Latin America (Katz, 2001).

Notably, the average CTTs in China, South Korea, and Taiwan stopped decreasing around the mid-2000s, and even reversed to show a slight increase (Figure 2.3A). As China, South Korea, and Taiwan move into long-CTT sectors, there is an increased likelihood that their respective innovation systems will converge with those of mature NIS countries.[18] In other words, the catching-up NIS economies initially pursued a path opposite that of the balanced or mature NIS by specializing in short-CTT sectors. However, they have now begun to move into long-CTT sectors, similar to incumbent economies. I refer to this pattern as a "detour" in the sense that these economies may eventually come to resemble mature balanced NIS countries via a catching-up NIS.

This detour is a variant of a nonlinear economic catching up by latecomers in the sense that an economy taking this detour does not go in the same direction (of long CTT sectors) as incumbent economies. Rather, it goes in the opposite direction and pursues short-CTT sectors during the catching-up stage of economic development. In other words, although the long-term destination of these countries may be long-CTT specialization, they take a nonlinear or U-shaped path, as indicated in the Figure 2.3A. Another example of this nonlinearity is found in the concentration of innovation in a small number of big businesses rather than the dispersion of innovation among many entities. This can be discussed in terms of Figure 2.3D, which shows the decentralization of innovation trends of different NIS groups. As expected, the advanced economies display the highest level, indicating that a wider or more dispersed

[18] For instance, the Samsung Group in South Korea declared biomedicine as its future growth engine, and created two subsidiaries. This organization's production capacity is already in the top two or three in the world.

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innovation base is desirable. The balanced catching-up group displays the second-highest value, which is also expected.

The next highest values belong to the imbalanced trapped and imbalanced catching-up NIS groups, which display relatively low levels of decentralization. In Figure 2.3D, the long-term trend, not the relative level of the imbalanced catching-up group, is of particular importance. It displays a U-shaped, nonlinear path. This downward trend continues. That is, innovation becomes increasingly centralized during the 1990s and 2000s, only to reverse in the 2010s. This reversal is more pronounced when we look at a graph for an individual economy, such as South Korea in the 2010s.[19] The U-shaped curve indicates that these catching-up economies experienced increased concentration of innovation among a small number of big inventors or businesses during the rapid catching-up period and then experienced subsequent decentralization after more recently becoming mature countries in the post-catching-up period.

In sum, the nonlinear pattern of transitional specialization into short-CTT sectors led by big businesses is an important element of the imbalanced catching-up pattern. What necessitates such a pattern? One answer is the need to circumvent entry barriers to high-end and value-added segments by seeking niches and concentrating resources and competencies in the hands of leading big businesses. Big businesses, especially in the form of business groups, benefit from the ability to mobilize and share resources among affiliates, which, in turn, facilitates entry into new business areas. This advantage is well documented in the literature.[20]

2.5 THE BALANCED SYSTEM AND THE INDIAN PATHWAY

The economic growth of the balanced catching-up NIS group (Singapore, Ireland, Hong Kong, Spain) is characterized by a steady increase in the five NIS indicators and a steady, linear catch-up with

[19] Such a figure is available as Figure 1 of Lee & Lee (2021).
[20] For instance, in Lee (2019, chapter 4) and Amsden and Hikino (1994).

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the economies of the balanced mature NIS group. The levels of the five NIS variables in this group range between those of the balanced mature group and those of both imbalanced groups. For instance, their levels of diversification and localization are below the values of the mature group but between those of the two imbalanced groups (Table 2.2). While the level of technological diversification of the balanced catching-up group is 0.3, which is half that of the imbalanced catching-up group, it is more than three times higher than that of the trapped group. Meanwhile, the level of localization of the balanced catching-up group is lower than that of the imbalanced catching-up group, which implies that the countries of the balanced catching-up group are pursuing more open innovation, which contrasts with the more closed innovation model of the imbalanced catching-up group.

In comparison, the average CTT of the balanced catching-up group is again between that of the mature advanced economies and the imbalanced catching-up economies; however, it is much shorter than that of the trapped NIS group (Figure 2.3A). In other words, the economies of the balanced catching-up group have not pursued extreme specialization into either short or long CTT. Economies in the balanced catching-up group pursued some specialization into short-CTT sectors beginning in the early 1980s and into the mid-1990s. From the mid-1990s onward, their average CTT levels remained consistent or close to the average value of 1.0. This medium level of CTT is also consistent with their intermediate technological diversification. However, a detailed analysis reveals that each country within the group has experienced a steady increase in technological diversification, from 0 to 0.1 in the 1980s and 1990s, and from 0.23 to 0.33 in the mid-2010s. Despite some variations in other aspects among these four economies, this steady increase in diversification is one of the strongest shared attributes of the balanced catching-up group. In contrast, the trapped economies have experienced a stagnation (never above 0.1) of diversification for the last four decades.

Given that this group of balanced catching-up NIS includes both peripheral European countries (Ireland, Spain, and Russia) and

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the city-economies of Hong Kong and Singapore, which opened their economies early, one can conjecture that countries in this group succeeded because they were relatively early starters and faced lower entry barriers amidst a more fluid international division of labor. That is, these economies did not inherit a "heavier degree of imbalances" (Hirschman, 1958) and thus faced lower entry barriers to possible sectors. The four balanced catching-up economies started as middle- and upper-income countries in the early 1960s; in contrast, the imbalanced catching-up economies began as low- or low-middle-income economies (see Figure 2.1).

Furthermore, one commonality of the trajectories of economies in the balanced catching-up NIS seems to be the emergence of not only manufacturing but also decent high value-added service sectors, such as IT services, engineering, and banking services. This is different from immature deindustrialization or servicization into low value-added services. Notable cases are the IT service sectors in Ireland and Singapore and engineering and banking services in Spain. In contrast, Hong Kong, which was once a British colony, is an extreme case of a service and trading hub for manufacturing in mainland China.[21] Thus, the economies of the balanced catching-up group have managed to maintain a certain amount of manufacturing relative to services; Hong Kong, with its special relationship with mainland China, is the exception. For instance, Singapore and Ireland kept their manufacturing as a percentage of GDP in the range of 20–25% until the mid-2000s.[22] In particular, Ireland featured a strong medical technology industry, which may be considered a long-CTT sector, whereas Singapore has featured strong innovators not only in manufacturing sectors, such as electronics (short CTT) and precision and transport engineering (long CTT), but also in knowledge-intensive business services.

[21] Discussion here relies on Breznitz (2012) and Cunningham et al. (2020) for Ireland, Sharif and Baark (2008) for Hong Kong, on Wong and Singh (2008) for Singapore, and Garcia Calvo (2014, 2016) for Spain, which has experienced the rise of high value-added service sectors and the fall of capital- and skill-intensive manufacturing.

[22] Calculations using the WDI (World Development Indicator) data of the World Bank.

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In sum, these balanced and catching-up economies share a certain degree of overlap in their active industrial policies. That is, by relying early on foreign direct investment and multinational enterprises, these economies successfully generated indigenous businesses in various manufacturing and service sectors.[23] Thus, it is also possible to compare balanced and imbalanced pathways by examining countries' tendencies to either specialize in a few niche areas or broaden their specialization to include more diverse areas, such as service sectors. Thus, while Nurkse (1953) emphasizes the need to balance agriculture and manufacturing, economies at the middle-income stage may actually need to strike some balance between manufacturing and services, as exemplified by the case of the balanced catching-up economies in our sample. In fact, Fagerberg and Verspagen (1999) indicate that manufacturing only acted as an engine of growth for developing countries but not developed ones.[24]

One can compare the relative productivity of services and manufacturing using the ratio of the relative productivity of services versus manufacturing, where the relative productivity of each sector is measured by the share of services (manufacturing) in GDP to the share of services (manufacturing) in employment. Then, if we calculate the ratio of the relative productivity of services to the relative productivity of manufacturing, the ratio variables can serve as a measure of the productivity of services relative to that of manufacturing. Calculations then show that this relative productivity of services tends to be highest (or higher than 1) in the balanced catching-up NIS group, whereas it is lowest in the imbalanced trapped group.[25] This may suggest that decent service sectors may have been the engine of catch-up growth in the balanced group, whereas the imbalanced trapped group was less successful in promoting high valued-added services.

[23] Refer to information from Cunningham et al. (2020) and O'Malley et al. (2008) for Ireland, as well as Wong and Singh (2008) for Singapore.

[24] This view is slightly different from that of Haraguchi et al. (2017), who reported the continuing importance of manufacturing globally.

[25] For details, see Lee et al. (2021), table 5.

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2.5.1 *The Case of India*

It is notable that India also belongs to the balanced mixed group despite still being a low middle-income country. Although India is not yet a high-income economy, its increasing rate of economic growth and balanced (between short and long CTT) industrial structure means that it will likely join the balanced catching-up group in the future. India also differs substantially from other trapped economies, given its high level of technological diversification. In terms of the evolution of NIS types, India was grouped with other trapped countries in the first two subperiods before 2000. Since 2000, India, alongside Ireland, joined the balanced mixed group that began with Singapore. This transition coincided with India's entrance into IT services beginning in the 2000s. Only during the most recent period (2008–2015) was this group joined by Russia, Denmark, Spain, Norway, and Hong Kong. The per capita GDP of India grew at the rate of 5.1% per annum during the 2008–2017 period compared with the 32-country average of 1.1% per annum; this growth rate is comparable to that of China. Therefore, if India sustains its current economic growth beyond the middle-income stage, its path can be defined not as an imbalanced catching-up NIS but as a balanced catching-up NIS.

India has recently registered a large number of US patents. Figure 2.4 shows the relative composition of six major categories of US patents filed by India. India was once strong in the long-cycle technologies of drugs and chemicals; however, the shares of these two classes have declined sharply since the 2000s as India has gained strength in IT services, which consequently increased its number of patent filings.[26] The share of patents related to computers and communication rose from less than 15% in the early 2000s to over 60% by the mid-2010s. Subsequently, India became a more balanced, medium-cycle, and tech-based NIS comprised of both long- and

[26] For the rise of IT services in India, refer to Porto et al. (2021), Rao et al. (2017), and Lee et al. (2014).

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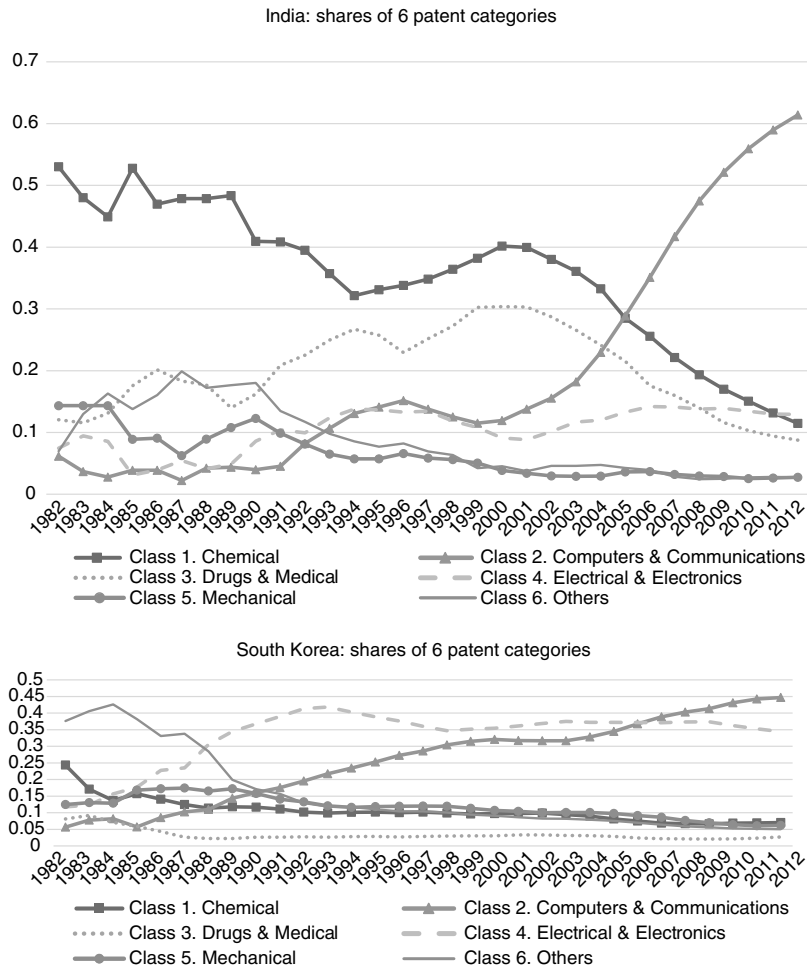

FIGURE 2.4 Relative distribution of patents by six categories: A: India and B: South Korea
Source: The author calculations using the US patent data.

short-cycle technologies. It has also steadily increased its level of technological diversification. In contrast, the graph for South Korea in Figure 2.4 is completely different from that of India. Figure 2.4 indicates the absolute dominance of short-cycle technologies in Korea (e.g., IT and telecom), and likewise, it shows a very small number of

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patents in long-cycle technologies. Consequently, South Korea has been classified as an imbalanced short-cycle NIS. Despite this narrow specialization, South Korea's level of technological diversification is high in terms of three-digit level classifications because many subclasses exist within the same short-cycle, tech-based classes. Indeed, the above pattern illustrates why and how India and South Korea differ from each other.

In addition to its existing strength in pharmaceuticals, India has also enhanced its IT services since the 1990s. This has been led by three extremely big businesses: Infosys, Wipro, and Tata Consultancy Services, two of which are listed on US stock markets and have generated numerous US patents. India's rise in IT services is also considered a case of leapfrogging, in the sense that India did not follow the traditional evolution from agriculture to manufacturing and finally services but instead skipped the stage of manufacturing-led growth to leapfrog into service-led growth.[27] The size of India's service sector has surpassed that of the manufacturing sector, and never in India's post-war history did the manufacturing sector command the largest share of GDP. India's entrance into the service sector is also different from premature servicization in Africa, as India's service sector is not based on low value-added sectors or the urban informal sector; instead, it is based on high value-added sectors and is globalized. India has specialized in the niche area of IT services and has taken advantage of its population of highly skilled workers with engineering backgrounds and English-speaking skills. IT services are also a short-cycle technology sector with low barriers to entry. Thus, it makes sense for latecomers at the middle-income stage to specialize in IT services.

Overall, India's economy is an interesting case, in that it contains both an element of aggregate or macro-level leapfrogging and a balanced technological structure consisting of both short- and long-CTT sectors.

[27] India as a case of leapfrogging is first discussed in my own work, Lee et al. (2014).

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2.6 A PATHWAY OUT OF THE TRAP: RESOURCE-BASED DEVELOPMENT IN CHILE AND MALAYSIA

The cluster analysis in Section 2.2 grouped eight emerging economies into the imbalanced trapped NIS cluster, which includes economies with per capita incomes less than 40% of the United States level that fall within the range of the MIT. As shown in Figures 2.1 and 2.2, many emerging economies, including Mexico, Brazil, and South Africa, have not closed the gap with the United States. However, upon closer inspection, the figures reveal that Malaysia and Chile have recently exceeded 40% of the level of US per capita income despite belonging to the imbalanced trapped group. Unlike other trapped countries, Chile and Malaysia have been growing at faster rates over the past decades. In 1990, both countries shared a similar per capita income level that was approximate to those of Brazil and Algeria yet lower than Mexico. By 2017, however, Chile and Malaysia surpassed Mexico and reached a per capita income of $23,000 or higher, placing both countries far ahead of Brazil and Algeria, whose per capita income remained below $15,000. According to Figure 2.2, Malaysia's per capita income reached 40.8% of the US level in 2013. Throughout the late 2010s, it remained at about 44% of the US level. According to Figure 2.1, Chile reached 40.7% of US per capita income in 2012 and stayed in this range up until the late 2010s. It can therefore be hypothesized that Chile and Malaysia seem to have grown beyond the MIT.

This begs the question of how both countries were able to escape the trap and which sectors, in particular, led economic and export growth. In research I undertook with colleagues (Lebdioui et al., 2021), we demonstrated that Chile and Malaysia were able to sustain economic growth not because of manufacturing but rather because of several leading resource-based sectors, such as petroleum, rubber, and palm oil in Malaysia and salmon, fruit, wine, and wood-based products in Chile.

To determine which sectors were responsible for growth beyond the MIT, colleagues and I compared the contribution of different

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sectors to the export performance of Chile and Malaysia according to several indicators, such as each sector's share of the country's total exports, trade balance, and their revealed comparative advantages (RCAs) over time. We focused on export performance because, compared to a factor such as trade openness (trade to GDP ratio), it is a much stronger binding factor for economic growth in the Global South.[28] Developing countries must earn hard currency by exporting to pay for the imported capital goods that are required for investments and sustained economic growth. Without strong exports, developing countries cannot be free from the balance of payment (BOP) deficit problem, which is a chronic problem in the Global South.

When we compared the export performance of the resources-based sector with the traditional leading sectors in Chile and Malaysia, we found that resource-based industries have been driving exports in both countries. In Chile, the combined export share of new resource-based industries (salmon, wine, fruit, and forestry) reached 28% in 2017, becoming the second-largest contributor to exports after mining (55%).[29] In Malaysia, the combined export share of resource-based industries (petroleum, palm oil, and rubber) reached 21% in 2017, which was second only to the electrical and electronic (E&E) sector (38%).[30]

More importantly, the ratio of trade surplus to total trade values in Chile in 2017 indicates that these resource sectors all achieved very high ratios (78% on average). This contrasts sharply with typical manufacturing sectors, such as machinery and transportation goods (–85%) and chemicals (–38%), which recorded very high deficit ratios. In Malaysia, the ratio of trade surplus to total trade in palm oil in 2017 reached as high as 87%, and in the combined resource sectors (palm oil, petroleum products, and rubber products), it reached 26%, which was still higher than the E&E sector (16%). In contrast, other

[28] This point is made in Brenton et al. (2010) and Ramanayake and Lee (2015).
[29] These figures are from UN trade data as cited in Lebdioui et al. (2021).
[30] These figures are from UN trade data as cited in Lebdioui et al. (2021).

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manufacturing sectors, such as machinery and transport equipment (–33%) and chemical products (–13%), recorded very high deficits.

A similar analysis of the trends of trade surplus by sector over time confirms the rising contribution of the new resource sectors. Indeed, since 2007, the combined trade surplus of the key resource sectors in Malaysia has become bigger than that of the E&E sector.[31] Since 2007, the contribution of the E&E sector has been mostly stagnant. Additionally, in Chile, the contribution of mining to the total trade surplus peaked in 2011 and has declined since then, whereas the combined share of key resources has been steadily increasing, reaching almost half of the amount of mining. The steady rise of trade surpluses in these resource sectors is in stark contrast to the ever-increasing deficits in the machinery and equipment sectors and other manufacturing sectors in Chile.

Lastly, I discuss Chile and Malaysia's RCA by sector.[32] RCA values larger than 1 indicate that the products of that country are internationally competitive. The RCA values in key sectors of Malaysia confirm the international competitiveness of new resource sectors. First, the RCA value of palm oil products has been extremely high at 30. Rubber and fuels were below 1 in 1995; however, since the mid-2000s, both of their RCA values exceeded 1. In contrast, throughout this period, the automobile sector has always recorded an RCA value below 0.2. The RCA values in the resource sectors in Chile, including wine, fish, fruit, and wood-based products, have stayed above 6 since 1995, meaning that these sectors are extremely competitive internationally.[33] The most dramatic increase was achieved in wine, which increased from an RCA of 6 in 1995 to over 15 in 2017. In

[31] The details are from figures in Lebdioui et al. (2021).

[32] Detailed figures are available upon request. The RCA metric can be used to provide a general indication of a country's competitive export strengths. The RCA for country z in product g is defined as the ratio of the share of goods g in total exports of country z to the share of goods g in total exports of the world.

[33] Wood-based products here correspond to the sum of products with the following SITC Rev. 3 (Standard International Trade Classification) codes: 63, 64, 24, and 25. Wood-based sector and forestry sector are used interchangeably in this paper.

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contrast, Chile's RCA in the mining sector (ores and metals) is much lower and has remained around 4 since 1995.

The above discussion has confirmed the rising contribution of resource sectors to exports, trade surpluses, and RCA. However, at this juncture, it is worth asking whether it is unprocessed resources that are generating less domestic value added. Therefore, we provide evidence that a progressive downstream value addition has taken place in the exports of these three sectors in Malaysia since the 1960s. The share of crude rubber and crude petroleum decreased from over 90% of total petroleum products in 1960 to less than 30% in the 2010s (Lebdioui et al., 2021). In contrast, rubber-based manufactured products as a share of total rubber exports increased to over 50% by 2012, while petroleum-based processed products as a share of total petroleum products increased from less than 10% to over 70% by 2014. The same shift from exporting crude to processed palm oil occurred in Malaysia, but an equivalent shift did not occur in Indonesia during the same period (Sato, 2016).

With regard to Chile, the new resource sectors are very sophisticated and technology intensive. For example, salmon production requires technologies such as cold storage systems and vaccines as well as the infrastructure to transport fresh products to distant markets (Lebdioui, 2020). Chile produces premium-quality fresh salmon and fresh berries that are exported to Japan and the United States. They are more value-added, knowledge-intensive, and technologically sophisticated than typical fish or fruit products. Wood-based products are not logs but rather include various kinds of value-added products such as pulp, paper, paperboard, cork, and furniture.

Successful catching up through specialization in resource-based sectors is consistent with the key argument of this study that latecomers should identify low barrier-to-entry sectors in the international division of labor. In fact, these resource-based sectors represent low barrier-to-entry sectors for many resource-rich emerging economies. Growth that relies on domestically available resources makes more sense in the post-pandemic era when countries are seeking

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more resilient development pathways that are less constrained by the risk of GVC disruption. One OECD report argued that strategies to recover from the COVID-19 crisis should include a strong structural component to reduce dependence on external financial flows and global markets and that countries should develop more value-added, knowledge-intensive, and industrialized economies (OECD, 2020). Latin American scholars (Perez, 2008) argued that emerging economies could use resource-based development to leapfrog into emerging technologies, such as IT. In contrast, my colleagues and I are of the view that resource sectors can serve as leading sectors that generate intra-sectoral diversification and the deepening of value chains. This contrasts with the existing argument that resource sectors are merely transitional sectors that generate financial revenue that can be utilized to promote economic diversification into non-resource sectors.

The next question to answer is how these two countries have been able to promote the upgrading of resource-based sectors as their respective engines of growth. In Malaysia, these resource-based industries have shown great degrees of linkage development, competitiveness, and technological sophistication, notably achieved through governmental support for R&D activities, which contrasts sharply with the weak performances of the Malaysian electronics and automotive sectors. In Chile, the emergence and growth of resource-based sectors into competitive export industries are related to long-term policies designed to strengthen local capabilities in production and innovation through both vertical and horizontal interventions. Section 3.2 of Chapter 3 will elaborate on the role of industrial policy and local ownership.

2.7 SUMMARY AND CONCLUDING REMARKS

This study used US patent data for 32 economies to measure, classify, and analyze the evolution and performance of their NIS, with a focus on economies that sustained economic growth beyond the middle-income stage. Cluster analysis identified several varieties

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of NIS that are comparable to the various types of capitalist economies. The analysis showed that in the NIS of advanced economies, the values of the five NIS component variables are all similarly high (and thus balanced), whereas the NIS values of emerging economies tend to be imbalanced and relatively uneven across the five NIS variables. These findings are consistent with existing studies (Cirera & Maloney, 2017), indicating that multiple parts of typical developing countries' NIS are underdeveloped.

Importantly, this study identified multiple pathways for achieving economic catch-up from middle-income status to high-income status. One of the identified pathways corresponded to the balanced catching-up NIS cluster, which includes the countries of Ireland, Spain, Hong Kong, and Singapore, as well as the two large economies of India and Russia. The other pathway corresponded to the imbalanced catching-up NIS cluster, which includes the two Asian tigers of Korea and Taiwan and, more recently, China. This bodes well for the future of China in terms of the prospect of the country growing beyond middle-income status. We also identified a third group, the trapped NIS cluster, consisting of economies perceived to be stuck in the MIT.

The imbalanced catching-up NIS in East Asia is characterized by an imbalance of very short CTT and low originality yet very high localization and diversification. The trapped NIS, in contrast, displays the exact opposite attributes. In comparison, the balanced catching-up cluster has equally balanced medium values for all of the NIS variables. The rapid economic catch-up of the countries in the imbalanced NIS group can be explained by the fact that these economies have increasingly specialized in short CTT, thereby increasing their respective levels of knowledge localization and technological diversification.

In comparison, the alternative pathway of the balanced catching-up group shows that extreme specialization in either long- or short-CTT sectors is not always necessary for achieving a decent degree of technological diversification and decentralization. The long

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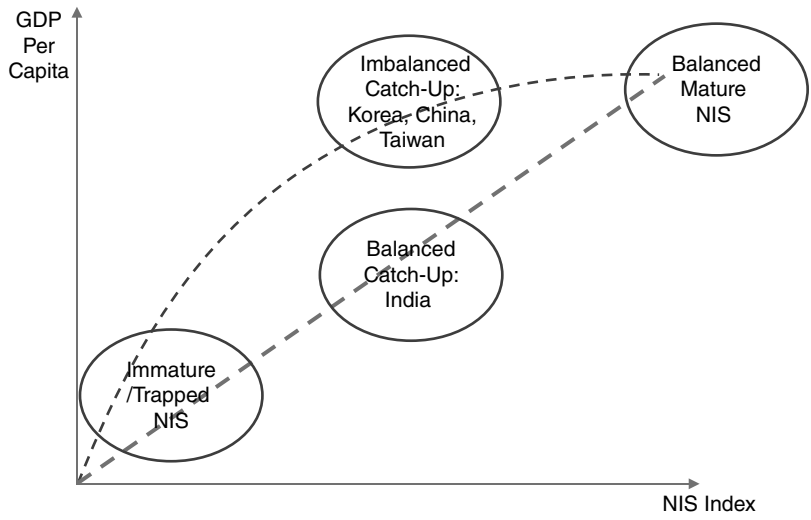

FIGURE 2.5 Two alternative pathways of catching up: balanced and imbalanced

CTT is a desirable feature, as shown by all long-CTT specialization in advanced economies; however, long CTT specialization is risky at the transition stage because it is associated with high barrier-to-entry sectors. In sum, these various patterns are still consistent with some correspondence between levels of CTT, localization, and diversification in latecomer economies. In other words, short-CTT specialization corresponds to high localization and diversification, whereas long-CTT specialization corresponds to low localization and diversification. Meanwhile, medium CTT corresponds to a medium level of localization and diversification.

The existence of two catching-up paths (balanced and imbalanced) corresponds to the classic debate about the two development strategies, namely the balanced (Nurkse, 1953) and the imbalanced strategy (Hirschman, 1958). Figure 2.5 illustrates these two alternative pathways. The graph indicates first that at earlier stages of economic development, the latecomer economies all tend to possess and start from an imbalanced trapped NIS. After this, either a linear or nonlinear pathway becomes available for them to develop into

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balanced mature NIS. The linear path is a path of balanced development that corresponds to the balanced NIS.

The nonlinear path is the path that East Asian economies have followed. That is, it is the imbalanced catching-up NIS pathway of specializing in short-cycle technologies, which is different from the long-cycle technologies of mature NIS economies. This path is thus a detour that begins with short-cycle sectors and then transitions to long-cycle ones. Imbalanced development also includes a detour from centralization to decentralization in terms of firm size distribution. In other words, these East Asian economies experienced the increasing importance of big businesses during the catching-up stage, given that these economies had experienced an increase rather than a decrease in the concentration of innovators within big businesses. In sum, the nonlinear pattern of transitional specialization into short-CTT sectors led by big businesses is an important element of the imbalanced catching-up pathway. This detour is necessary to circumvent entry barriers to high-end and value-added sectors and enable countries to seek out niches and concentrate resources and competencies in the hands of leading big businesses.

One important observation of this chapter is the correspondence between various NIS types and experiences of catching up or falling behind. The five NIS clusters were shown to correspond largely with various economic outcomes.[34] On the basis of these findings, one important policy implication is that the currently trapped economies may have not just one but several alternative pathways to overcome the MIT. India is also an interesting case because it is still a low middle-income economy and a member of the balanced NIS cluster, which may bode well for the future of its economy. India's catch-up is currently driven by both long-cycle

[34] Of course, there are outliers like Japan and Israel, which did not join either of the two catching-up NIS groups. It is interesting to note that whereas in a previous study (Lee, 2013c). I put all four Asian tigers in the same group, this study now shows that they followed two different paths at later stages, with Korea and Taiwan following the imbalanced NIS path and Hong Kong and Singapore following the balanced NIS path.

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sectors, such as pharmaceuticals, and short-cycle sectors, such as IT services. India entered the pharmaceutical sector at a very early stage when entry barriers were relatively low.

While the balanced catching-up group features some balance between manufacturing and services, another possible combination may be a balance between manufacturing and resource-based sectors. This possibility is discussed in relation to the outstanding success of Chile and Malaysia, which both show signs of escaping the MIT not through manufacturing success but through the emergence of several resource-based sectors that are leading exporters of high value-added goods. Growth that relies on domestically available resources makes more sense in the post-pandemic era when countries are seeking more resilient development pathways that are less constrained by the risk of GVC disruption.

Based on the above discussion, we can make a final observation about a possible way out for economies now in the MIT. For countries with a national economy of a certain size and some resource endowments, such as Brazil, South Africa, and Argentina, one option may be a "balanced catching up" that promotes not only manufacturing but also resource-based sectors and IT services. These countries can learn from the experiences of Russia and India, which belong to the balanced catching-up NIS cluster, as well as from Chile and Malaysia. This option might also be applicable to countries such as Mexico, Thailand, and Turkey, which have had some experience in traditional manufacturing. Like Malaysia, they have also encountered difficulty in upgrading into high-end or value-added segments of manufacturing owing to high entry barriers.

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